

Oral health effects of smokeless tobacco use in Navajo Indian adolescents

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Abstract – Recent reports have suggested that the use of smokeless tobacco is increasing in adolescents, and is particularly high in Native Americans, causing concern about possible effects on oral health. In this study, 226 Navajo Indians, aged 14-19, were interviewed regarding their use of smokeless tobacco (ST), cigarettes, and alcohol. Midbuccal and mesiobuccal sites on all fully erupted permanent teeth (excluding third molars) were examined for the presence of gingival bleeding, gingival recession, calculus, and loss of periodontal attachment. The oral mucosa was examined for evidence of leukoplakia. 64.2% (145) of the subjects (75.4% of the boys and 49.0% of the girls) were users of ST. Of these, over 95% used snuff alone or in combination with chewing tobacco. 55.9% used ST one or more days per week. 52.2% consumed alcohol, usually beer or wine, and 54.0% smoked cigarettes. 25.5% (37) of the users and 3.7% (3) of the non-users had leukoplakia. The duration (in years) and frequency of ST use (days per week) were highly significant risk factors associated with leukoplakia. However, the concomitant use of alcohol or cigarettes did not appear to increase the prevalence of these lesions. No consistent relationship was observed between the use of ST and gingival bleeding, calculus, gingival recession, or attachment loss, either when comparing users to non-users or when comparing the segment where the tobacco quid was habitually placed to a within-subject control segment. In view of these results, there is little doubt that smokeless tobacco is significantly related to the etiology of leukoplakia. As some evidence exists that smokeless tobacco use is a significant risk factor associated with oral carcinoma, intervention programs to discourage the use of smokeless tobacco by adolescents should be a public health priority.

Key words: adolescence; Indians, North American; leukoplakia; Navajo; periodontal diseases; smokeless tobacco

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The use of smokeless tobacco by adolescents and its reported adverse oral health effects have received widespread attention in the United States during the past 5 yr. While the prevalence of cigarette smoking in these age groups appears to be stable, or in many cases decreasing (1), the sales of smokeless tobacco products and their use by adolescents is on the rise (2). Adverse oral health effects reported to be associated with smokeless tobacco use include dental caries, gingival recession, periodontitis with loss of alveolar bone, leukoplakia, and oral cancer (3-18).

The prevalence of smokeless tobacco use in Native American adolescents is reportedly substantially higher than in Caucasians (19-23), but little is known about the extent of related adverse oral

health effects in these groups. This investigation determined the prevalence of smokeless tobacco use in a group of Native American adolescents, with special attention to the characteristics of use, as well as the prevalence and severity of leukoplakia, gingival bleeding, supra- and subgingival calculus, gingival recession, and destructive periodontal disease as measured by probing for attachment loss.

Methods

The study population consisted of 226 Native American adolescents; 130 (57.5%) were boys and 96 (42.5%) were girls (Table 1). Most were of Navajo or mixed Navajo parentage. They were en-

rolled in the 9th or 10th grade in a US Government boarding school at Fort Wingate, New Mexico (USA).

Subjects were examined at a clinical facility on the school grounds. A bilingual (Navajo/English) study assistant administered a questionnaire in English to each subject during a private interview and, when necessary, translated the questions into Navajo. Subjects were asked to respond to questions about their use of smokeless tobacco, smoking tobacco, and alcohol.

Clinical examinations included assessments for gingival bleeding, supra- and subgingival calculus, periodontal attachment loss, and gingival recession on 28 fully erupted permanent teeth (excluding third molars). Two sites were examined per tooth, the midbuccal and the mesio-

Table 1. Distribution of subjects by age and sex

Age in yr	n (% of subjects)		Both
	Boys	Girls	
14	7	12	19 (8.4)
15	23	31	54 (23.9)
16	53	39	92 (40.7)
17	28	11	39 (17.3)
18	14	2	16 (7.1)
19	5	1	6 (2.7)
14-19	130 (57.5)	96 (42.5)	226 (100.0)

buccal, for a total of 56 possible sites per subject.

Gingival bleeding was assessed according to a modification of the Gingival Index (24), and was considered present if bleeding occurred within 15 s after gentle manipulation of the gingival margin with a periodontal probe. Loss of periodontal attachment was determined using the technique proposed by RAMFJORD (25), and was considered present if the distance from the cemento-enamel junction

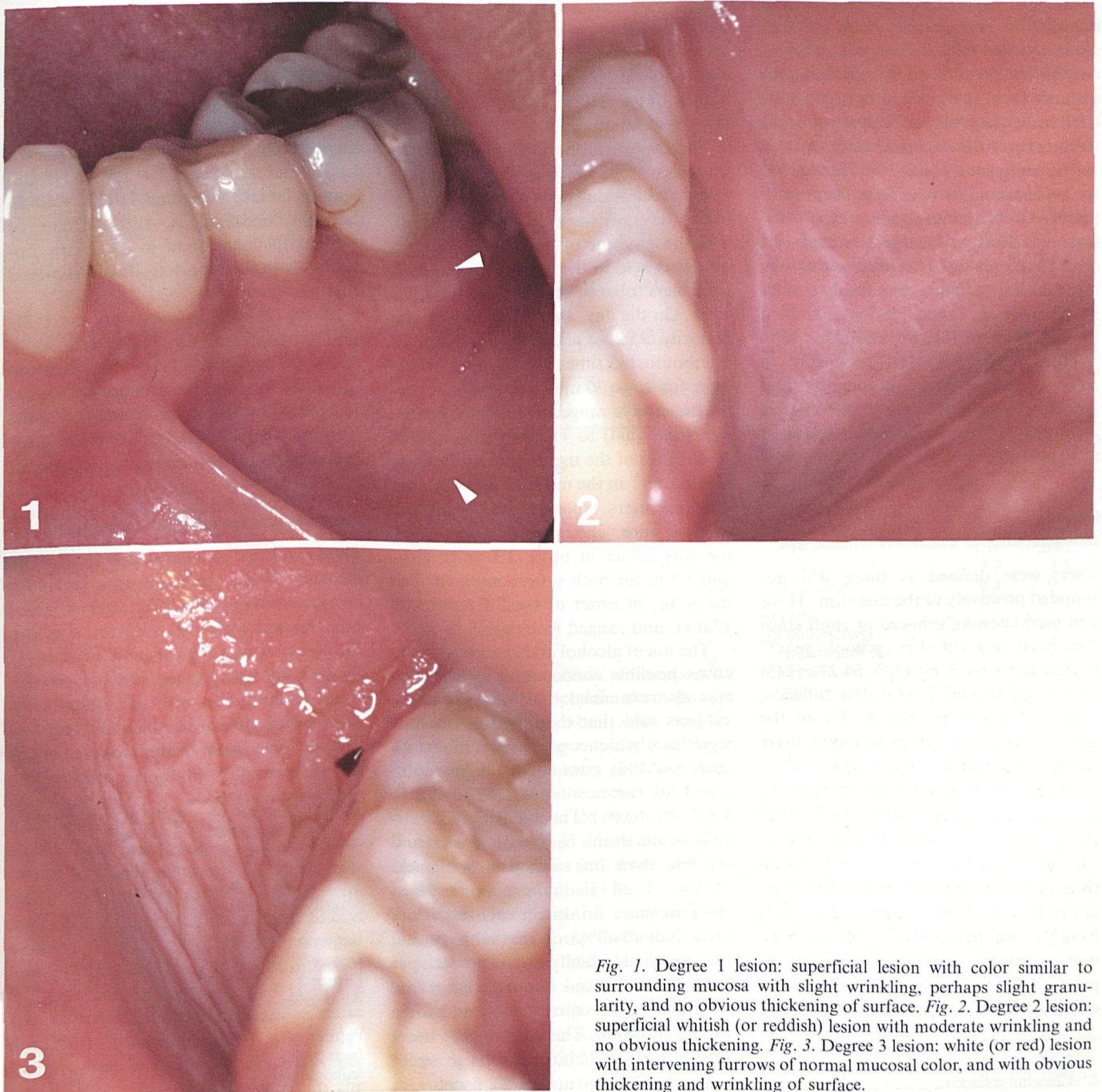


Fig. 1. Degree 1 lesion: superficial lesion with color similar to surrounding mucosa with slight wrinkling, perhaps slight granularity, and no obvious thickening of surface. Fig. 2. Degree 2 lesion: superficial whitish (or reddish) lesion with moderate wrinkling and no obvious thickening. Fig. 3. Degree 3 lesion: white (or red) lesion with intervening furrows of normal mucosal color, and with obvious thickening and wrinkling of surface.

(CEJ) to the base of the gingival sulcus was ≥ 2 mm (measured using an NIDR probe, #2-12). These diagnostic criteria and methods are fully described in an earlier paper (26).

An examination for the presence of calculus was conducted by inserting an explorer (No. 17) beneath the gingival margin distal to the midbuccal site and moving it into the mesiobuccal site using a smooth stroke. Calculus was scored at each site as none, supragingival only, and subgingival with or without supragingival.

Gingival recession was diagnosed if the gingival margin was 1 mm or more apical to the CEJ. The amount of recession was determined by measuring the distance from the gingival margin to the CEJ, using the same probe, and rounding to the nearest lower whole millimeter.

The oral soft tissues were examined for evidence of leukoplakia without prior knowledge of the responses to the questionnaire. For purposes of this study the term "leukoplakia" was used to describe mucosal lesions characteristically similar to the degree 1, 2, and 3 lesions classified by GREER *et al.* (8). Leukoplakias were photographed, described according to color, texture, extent, and location, and graded for severity using the criteria mentioned above, which are illustrated in Figs. 1-3.

Results

Characteristics of smokeless tobacco use

Users were defined as those who responded positively to the question "Have you used chewing tobacco or snuff since the beginning of the school year?" (within the past 7 months). 64.2% (145) of the subjects used smokeless tobacco, 75.4% of the boys, and 49.0% of the girls (Table 2). The prevalence of users showed little variation with age.

Each user was asked to identify the brand(s) of smokeless tobacco (ST) they used, in order of decreasing frequency. The most popular product was Skoal (Regular or Long Cut)* followed by Levi Garrett**, Hawken*, Copenhagen*, Red Man**, and Beech-Nut**. 89% of the users identified a brand of snuff as the product of first choice. 58.6% used snuff only (one or more brands), compared to

Table 2. Use of smokeless tobacco (ST) by type of product, age and sex

Age in yr	Type of ST (both sexes)		Smokeless tobacco users n (%)		
	Snuff	Chewing tobacco	Boys	Girls	Total
14	11	1	6 (85.7)	6 (50.0)	12 (63.2)
15	33	4	19 (82.6)	18 (58.1)	37 (68.5)
16	52	9	46 (86.8)	5 (38.5)	61 (66.3)
17	22	1	15 (53.6)	8 (72.7)	23 (59.0)
18	7	1	8 (57.1)	0 (0.0)	8 (50.0)
19	4	0	4 (80.0)	0 (0.0)	4 (66.7)
14-19	129	16	98 (75.4)	47 (49.0)	145 (64.2)

36.6% who used snuff and chewing tobacco, and 4.8% who used chewing tobacco only (one or more brands). 51.0% used only one brand of ST, 27.6% two brands, and 21.4% three brands of smokeless tobacco.

The exposure of the oral mucosa to smokeless tobacco was determined in terms of duration (years used), frequency of use (days per week and times per day), and the amount of time each tobacco quid was held in the mouth. 55.9% used smokeless tobacco one or more days per week. On the days that ST was used, the majority (95.2%) placed fresh tobacco in the mouth 1-5 times per day and held it there for up to 30 min; thus the exposure on these days ranged from less than 30 min (one quid) to 150 min (five quids). 38.6% (56) of the users reported holding a quid of ST in the mouth while sleeping. Only six users reported swallowing the tobacco juice. The mean duration of ST use was 3.5 yr in boys, 2.3 yr in girls, and 3.1 yr for both sexes combined. The mean age of onset of the ST habit was 12.6 yr, and ranged from age 5 to 17.

The use of alcohol and smoking tobacco as possible concomitant risk factors was also examined. 52.2% (118) of all subjects said that they used alcohol. A significantly higher proportion of the ST users (62.1%) consumed alcohol compared to the non-users (34.6%) ($\chi^2 = 14.67$, $P < 0.001$). The majority of the alcohol-users drank beer and/or wine, and on less than one occasion per week. 54.2% of all alcohol-users consumed three or more drinks on each occasion. Over half (54.0%) of the subjects said they smoked, usually 1-5 cigarettes per week. ST users and non-users appeared to smoke to an equal extent, and for a similar duration. The mean age of onset of the smoking habit was 14.6 yr in ST users, and 14.8 yr in non-ST users.

Prevalence of leukoplakia

Leukoplakia was found in 40 subjects; 37 (25.5%) in ST users, and three (3.7%) in non-users (odds ratio = 8.9, $P < 0.001$). All leukoplakias were found in the mandibular arch; 22 (55.0%) were located in the left buccal sulcus, 7 (17.5%) in the anterior labial sulcus, and 11 (27.5%) in the right buccal sulcus. All but three of the leukoplakias found in ST users coincided with the reported site of habitual quid placement.

29.6% (29) of the boys who used ST had leukoplakia as compared with 17.0% (8) of the girls (Table 3). The leukoplakias for both sexes combined were distributed by severity as follows: 51.4% (19) were degree 1, 16.2% (6) were degree 2, and 32.4% (12) were degree 3 lesions.

Risk factors associated with leukoplakia

The prevalence of leukoplakia tended to increase as the years of exposure increased, peaking at 62.5% after 4 yr of use, but was lower (21.1%) for the duration interval of 5 yr or more (Table 4). Despite the unexplained reversal of this trend in the group with the longest exposure, duration of use was a highly significant risk factor associated with the

Table 3. Number of severity of leukoplakias in smokeless tobacco users by sex

Severity	Boys (n=98)		Girls (n=47)		Both sexes (n=145)	
	n (%)		n (%)		n (%)	
Degree 1	15	4	19	51.4		
Degree 2	5	1	6	16.2		
Degree 3	9	3	12	32.4		
All degrees	29	8	37	100.0		
Percent of users with leukoplakia	29.6	17.0	25.5			

* Snuff.

** Chewing tobacco.

Table 4. Relative risk of leukoplakia by duration (years) of smokeless tobacco habit

Duration in yr	Subjects with leukoplakia (n)	Subjects (n)	Prevalence of leukoplakia (%)	Relative risk of leukoplakia
None	3	81	3.7	—
≤1 yr	6	45	13.3	3.6
2 yr	3	20	15.0	4.1
3 yr	10	26	38.5	10.4
4 yr	10	16	62.5	16.9
≥5 yr	8	38	21.1	5.7

Table 5. Frequency of smokeless tobacco use by evidence of leukoplakia

Frequency of use	Smokeless tobacco users	
	With leukoplakia (n=37) n (%)	Without leukoplakia (n=108) n (%)
<i>Less than one day per week</i>		
Occasionally	7 (18.9)	57 (52.8)
Once per month	5 (13.5)	35 (32.4)
Every 2 wk	2 (5.4)	17 (15.7)
	0 (0.0)	5 (4.6)
<i>One or more days per week</i>		
1–2 days/wk	30 (81.1)	51 (47.2)
3–4 days/wk	14 (37.8)	28 (25.9)
5+ days/wk	6 (16.2)	8 (7.4)
	10 (27.0)	15 (13.9)

Table 6. Prevalence of leukoplakia by tobacco and/or alcohol habit

Alcohol or tobacco habit	No. of subjects		Prevalence (%) of leukoplakia
	With leukoplakia	Without leukoplakia	
None	3	37	8.1
Smokeless only	11	36	30.6
Smokeless and alcohol	9	25	36.0
Smokeless, smoking, and alcohol	16	66	24.2
Smokeless and smoking	1	18	5.6
Alcohol only	0	6	0
Smoking only	0	16	0
Smoking and alcohol	0	22	0

presence of leukoplakia ($\chi^2=18.9$, $P<0.001$).

That duration of use was an important contributory factor was also evident when comparing the difference in the mean duration of use between users with and without leukoplakia, and the difference in the prevalence of leukoplakia between boy and girl users. The mean duration of use was longer in users with leukoplakia than in those without; 3.5 yr versus 2.9 yr. 29.9% of the boy users had leukoplakia and their mean duration of ST use was 3.8 yr, while 17.0% of the girl users had leukoplakia and a mean duration of use of 2.5 yr.

The frequency of ST use (days per week) was also strongly related to the

presence of leukoplakia. Subjects with and without leukoplakia were divided into two categories: those who used ST less than one day per week, and those who used it one or more days per week (Table 5). 81.1% of the users with leukoplakia used ST one or more days per week, compared to 47.2% of those without leukoplakia. This difference was also highly significant ($\chi^2=11.48$, $P<0.001$). However, there was no consistent relationship between any of these characteristics of ST use and the severity of leukoplakia.

The prevalence of leukoplakia in subjects with various tobacco and alcohol habits is shown in Table 6. The highest prevalence of leukoplakia (36.0%) was

found in subjects who used smokeless tobacco and alcohol. However, the difference between users of ST only, and ST users who also used alcohol with or without smoking tobacco was not statistically significant.

Periodontal status

The relationship between the use of smokeless tobacco and periodontal status was examined by comparing ST users and nonusers with regard to the extent (percent of sites affected) and severity of attachment loss and gingival recession, and the extent of gingival bleeding and calculus. The methods for calculating extent and severity are fully described in a previous paper (27). The analyses were done using the 28 mandibular sites only, as all users held the quid in the mandibular arch. In addition, the segment of the mandibular arch where the quid was habitually placed was compared to a contralateral segment, using the same indicators of periodontal status. Seven users

Table 7. Mean extent of gingival bleeding and calculus, and extent and severity of attachment loss, and recession in smokeless tobacco users and non-users (28 mandibular sites only)

Periodontal condition	Smokeless tobacco	
	Users	Non-users
<i>Extent</i> (% of sites affected)		
Gingival bleeding	6.2	7.1
Calculus	21.6	20.5
Attachment loss	3.9	3.3
Recession	0.4	0.6
<i>Severity</i> (in millimeters)		
Attachment loss	2.3	1.9
Recession	0.1	0.2

Table 8. Mean extent of gingival bleeding, and extent and severity of attachment loss and recession in smokeless tobacco users at quid segment and control segment

Periodontal condition	Segment	
	Quid	Control
<i>Extent</i> (% of sites affected)		
Gingival bleeding	6.3	6.8
Attachment loss	3.2	3.7
Recession	0.7	0.1
<i>Severity</i> (In millimeters)		
Attachment loss	0.4	0.4
Recession	0.0	0.0

(4.8%) who held the quid in the mandibular labial sulcus were excluded from the analysis because there was no corresponding "control" segment in the same arch.

There were virtually no differences in the extent of gingival bleeding or calculus, or in the extent or severity of gingival recession or attachment loss between the quid segments and the control segments, or between users and non-users of smokeless tobacco (Tables 7 and 8).

Discussion

In recent studies, current use ("used within the past week") of smokeless tobacco among teenaged Caucasians has been reported to be as high as 19.6% of boys, though usually 3% or less of girls (19). In contrast, the prevalence of ST use in Native American adolescents is generally much higher; 18.4–42.6% of boys and 2.7–34.0% of girls residing in Minnesota, Oregon, Washington and Alaska reported that they were weekly users (19, 21–23).

This study confirmed the high prevalence of smokeless tobacco use in Native American boys and girls. Somewhat surprising was the finding that 54.0% of all subjects, and 57.9% of the ST users, smoked cigarettes, as reports indicate that Indians residing in Southwestern U.S. generally smoke much less than Caucasians (28, 29). These adolescents evidently did not consider the use of smokeless tobacco a "safe" alternative to smoking; instead, they began using ST at a mean age of 12.6 yr and later began smoking cigarettes at an average age of 14.6 yr.

Also confirmed were the results of PEACOCK *et al.* (10) and PINDBORG *et al.* (11) which implicated the use of ST, and especially snuff, in the etiology of leukoplakia. In this study population, the odds of developing these lesions in users of ST was nearly nine times that of non-users. This is a conservative estimate; at least two of the three "non-users" with leukoplakia were former users who had stopped before the time period defined as "current use" in this study. The magnitude of the relative risk of leukoplakia in users, combined with the high degree of correspondence between the site of the lesion and the reported site of quid placement, leaves little question about the eti-

ologic association of smokeless tobacco and leukoplakia.

In this study, the duration of use and the frequency of use of smokeless tobacco were the only significant determinants of the presence of leukoplakia in users. Neither concomitant use of alcohol or cigarette smoking, or both, appeared to increase the prevalence of lesions, which is in agreement with results of GREER *et al.* (8), and POULSON *et al.* (9).

We did not find an association between the use of smokeless tobacco and gingival bleeding or destructive periodontal disease, although such effects have been suggested by others (5–9). In those reports, the terms "periodontal degeneration" and "gingival recession" have often been imprecisely defined. Most authors appear to be referring to the apical migration of the attached gingiva to or below the CEJ at the site of quid placement; however, the diagnostic methods and criteria were incompletely described, and there were inadequate or no controls used.

An exception was the well-controlled study reported by MODÉER *et al.* (4) who observed a significant correlation between snuff use and gingivitis. However, this was based on Gingival Index scores which were mainly indicative of color change and edema, rather than gingival bleeding. Also, the subjects, who were Swedish adolescent men, presumably used a snuff product which was chemically different from those available in the U.S. (30).

Although incipient periodontitis was common in this population (26), ST users were no different than non-users with respect to gingival recession, gingival bleeding, and loss of periodontal attachment as determined by probing and analyzed quantitatively. Further, there was no evidence that, in ST users, the segment of the mouth in which the quid was habitually held had more gingival bleeding, recession, or attachment loss than the contralateral area in the same subject.

This does not seem surprising. Both gingival bleeding and attachment loss with pocket formation are generally considered to be the result of bacterially-induced inflammatory processes, and there is no a priori reason to believe that these conditions would be more severe in users in smokeless tobacco. The previously reported occurrence of marked gingival recession located at the site of quid placement (5–9), whether from chronic mechanical or chemical trauma, seems plausible, but it was not observed in these subjects. In fact, only six (4.1%) of the smokeless tobacco users had gingival recession in the segment of the mandibular arch where the quid was habitually held, and in each case there was only 1 mm of recession.

The oral health implications of the widespread use of smokeless tobacco by adolescents are difficult to assess as the existing data on the relationship between smokeless tobacco use, associated leukoplakia, and oral carcinoma are incon-

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sistent and incomplete. Leukoplakias, in general, are considered precancerous lesions because oral carcinomas frequently have been associated with areas of leukoplakia (13–15), and that some leukoplakias, observed over time, have undergone malignant transformation (12). However, the extent to which smokeless tobacco-associated leukoplakias become malignant is unclear. Several authors have reported a direct association between the use of smokeless tobacco and oral cancer (10, 16–17), but did not state whether the malignancies were preceded by leukoplakia. Others have found little or no evidence that ST is a human carcinogen (31–34). In general these studies are difficult to interpret, as most were uncontrolled for the confounding variables, of alcohol use and smoking. The most informative study to date was a well-controlled retrospective investigation by WINN *et al.* (18) who reported a nearly 50-fold increase in risk for carcinomas of the gingiva and buccal mucosa in black women who had used snuff for at least 50 yr.

In the aggregate, the available data suggest that the risk of oral carcinoma associated with the use of smokeless tobacco is quite small. Nevertheless, this habit is becoming so widespread among adolescents, as evident in this study and others, that the long-term use of these products can be expected to result in serious mucosal pathology in a significant number of individuals. Therefore, intervention programs to discourage the use of smokeless tobacco products should be a public health priority.

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